Journal of Pediatric Psychology, 42(8), 2017, 825–836
doi: 10.1093/jpepsy/jsx052
Advance Access Publication Date: 21 March 2017
Original Research Article

Sleep Hygiene and Sleep Outcomes in a Sample of Urban Children With and Without Asthma

Sarah R. Martin,[1,2] PhD, Julie Boergers,[1,2] PhD, Sheryl J. Kopel,[1,2] MSc, Elizabeth L. McQuaid,[1,2] PhD, Ronald Seifer,[1,2] PhD, Monique LeBourgeois,[3] PhD, Robert B. Klein,[2] MD, Cynthia A. Esteban,[2,4] PNP, MPH, Gregory K. Fritz,[1,2] MD, and Daphne Koinis-Mitchell,[1,2] PhD

[1]Bradley/Hasbro Children's Research Center, [2]Alpert Medical School, Brown University, [3]University of Colorado Boulder, and [4]Hasbro Children's Hospital/Rhode Island Hospital

All correspondence concerning this article should be addressed to Daphne Koinis-Mitchell, PhD, Bradley/Hasbro Children's Research Center, 1 Hoppin St, Providence, RI 02903, USA. E-mail: dkoinismitchell@lifespan.org

Received September 15, 2016; revisions received January 27, 2017; accepted January 28, 2017

Abstract

Objective To assess sleep hygiene and the sleep environment of urban children with and without asthma, and examine the associations among urban stressors, sleep hygiene, and sleep outcomes. **Methods** Urban children, 7–9 years old, with ($N = 216$) and without ($N = 130$) asthma from African American, Latino, or non-Latino White backgrounds were included. Level of neighborhood risk was used to describe urban stress. Parent-reported sleep hygiene and daytime sleepiness data were collected using questionnaires. Sleep duration and efficiency were assessed via actigraphy. **Results** Higher neighborhood risk, not asthma status, was associated with poorer sleep hygiene. Controlling for neighborhood risk, sleep hygiene was related to daytime sleepiness. Asthma status, not sleep hygiene, was related to sleep efficiency. In children with asthma, poorer sleep hygiene was associated with shorter sleep duration. **Conclusion** Considering urban stressors when treating pediatric populations is important, as factors related to urban stress may influence sleep hygiene practices and sleep outcomes.

Key words: asthma; chronic illness; disparities; sleep.

Sleep impacts all aspects of health and influences a child's biological (e.g., brain development, immune function), cognitive (e.g., memory consolidation, learning), and psychological (e.g., emotion regulation) functioning (Kurth, Olini, Huber, & LeBourgeois, 2015; Mindell & Owens, 2015). *Sleep hygiene*, or the practice of using sleep-related strategies such as a consistent sleep/wakefulness schedule; a calm, developmentally appropriate, bedtime routine; and *a healthy sleep environment* (e.g., minimal bedroom disruptions) promote good sleep health in children (Koinis-Mitchell, Kopel, Boergers, McQuaid, et al., 2015). Good sleep health is achieved through continuous sleep with few nighttime awakenings (i.e., sleep efficiency), sleeping the recommended number of hours in accordance with an individual's age (i.e., sleep duration), and maximal daytime alertness (i.e., minimal daytime sleepiness; Meltzer, Plaufcan, Thomas, & Mindell, 2014).

Sleep Hygiene and Health in Urban Minority Children

Racial, ethnic, and socioeconomic disparities exist with respect to children's sleep health outcomes. Ethnic minority children are found to have shorter nocturnal sleep duration as assessed by subjective (Crosby, LeBourgeois, & Harsh, 2005; Spilsbury et al., 2004) and objective (Kieckhefer, Ward, Tsai, & Lentz, 2008) measures. Lower socioeconomic status (SES) has been associated with shorter sleep duration in children from low income and ethnic minority backgrounds (El-Sheikh et al., 2013). Further, low

SES and poor neighborhood conditions are associated with inconsistent weekly sleep patterns and later sleep onset times in urban adolescents (Marco, Wolfson, Sparling, & Azuaje, 2012). Accordingly, aspects of the socio-contextual environment merit consideration when assessing sleep hygiene and sleep health outcomes in urban minority children.

Limited research exists on sleep hygiene behaviors and sleep environments in urban children. Studies that do exist use self-report measures, and indicate that maintaining good sleep health may be challenging in this group (Koinis-Mitchell, Kopel, Boergers, McQuaid, et al., 2015; Wilson, Miller, Lumeng, & Chervin, 2014). Urban socio-contextual stressors (e.g., neighborhood noise, crowded housing) may negatively affect sleep hygiene behaviors and sleep outcomes (e.g., sleep duration, sleep efficiency, sleep schedules) in urban children. Research on sleep hygiene behaviors and how they affect objective (e.g., sleep efficiency) and subjective (e.g., daytime sleepiness) sleep outcomes in diverse urban children is needed to inform interventions focused on improving sleep and health outcomes in this high-risk group.

Asthma and Sleep Outcomes

Children with a chronic illness are at increased risk for sleep disruption due to illness-related symptoms (Boergers & Koinis-Mitchell, 2010). Asthma is the most prevalent childhood chronic illness and is disproportionally present in African American (AA) and Latino, particularly Puerto Rican, children and those living in urban neighborhoods (Canino et al., 2006; Koinis-Mitchell et al., 2010). A higher proportion of minority children tend to reside in urban neighborhoods and live in poverty (Gabe, 2013), which puts them at risk for exposure to environmental triggers (Gruchalla et al., 2005), neighborhood violence (Turyk et al., 2008), and poor medication adherence (McQuaid et al., 2012), each of which contributes to poor asthma management and morbidity (Koinis-Mitchell et al., 2007; McQuaid et al., 2012).

Nocturnal asthma symptoms, more often observed in children with persistent asthma (Chugh, Khanna, & Shah, 2006; Koinis-Mitchell, Craig, Esteban, & Klein, 2012), have been associated with nighttime awakenings, shorter sleep duration, and poor sleep quality, which all negatively affect daytime functioning and academic outcomes (Daniel, Boergers, Kopel, & Koinis-Mitchell, 2012; Luyster et al., 2012). Findings from recent studies indicate that poor sleep hygiene practices amplify the association between poor asthma control and sleep behaviors that disturb sleep quality (Koinis-Mitchell, Kopel, Boergers, Ramos, et al., 2015). Better sleep hygiene also has a protective effect on sleep duration, even in the context of higher levels of neighborhood risk (Koinis-Mitchell, Kopel, Boergers, McQuaid, et al., 2015). Collectively, urban children with asthma are at an increased risk for poor asthma control and poor sleep outcomes, and optimal sleep hygiene may help mitigate this risk (Koinis-Mitchell, Kopel, Boergers, McQuaid, et al., 2015).

Although in prior work, sleep outcomes in urban children with asthma have been described (Koinis-Mitchell, Kopel, Boergers, McQuaid, et al., 2015), these studies have not yet compared sleep environment characteristics or sleep hygiene behaviors in urban children with and without chronic illness. It is important to further our understanding of how urban contextual stressors may affect sleep hygiene behaviors in these groups and whether children with chronic illness may be at an increased risk for poor sleep hygiene behaviors. Given that urban children and children with asthma are at risk for poor sleep health, it is important to enhance understanding of sleep behaviors and sleep environment characteristics affecting sleep outcomes in urban children both with and without chronic illness. Doing so may reveal potential intervention targets across groups that are within families' control, such as improving sleep hygiene.

The overall goals of the current study were to (1) describe the sleep hygiene behaviors and sleep environment characteristics of a sample of urban children from AA, Latino, and Non-Latino White backgrounds with persistent asthma or with no chronic illness, and (2) determine whether urban stress or having asthma was associated with sleep hygiene and objectively and subjectively measured sleep outcomes (i.e., sleep duration, sleep efficiency, and daytime sleepiness).

We first evaluated whether differences between children with and without asthma existed in (a) overall sleep hygiene, (b) components of sleep hygiene that are physiologically, emotionally, or environmentally based, and (c) aspects of the sleep environment (e.g., location, noise, number of people in the home) and whether differences existed when controlling for urban stress. We hypothesized that aspects of the sleep environment would be similar in urban children with and without asthma and that the association between urban stress and aspects of the sleep environment would be similar across groups.

Next, we examined whether having asthma is a unique risk factor for poor sleep hygiene beyond urban contextual stressors. As in other work (Canino et al., 2012; Koinis-Mitchell, Kopel, Boergers, McQuaid, et al., 2015), we used level of neighborhood risk as an indicator of urban stress. Given that urban minority children are at risk for poor sleep hygiene (Wilson et al., 2014) and managing asthma may challenge the implementation of healthy sleep behaviors (Koinis-Mitchell, Kopel, Boergers, Ramos, et al., 2015), we hypothesized that children with asthma would have poorer sleep hygiene even when controlling for urban stress.

Finally, to build on previous findings showing a link between sleep hygiene and sleep outcomes and to confirm that sleep hygiene would be associated with more optimal sleep outcomes regardless of whether a child has asthma (Mindell, Meltzer, Carskadon, & Chervin, 2009; Owens, Spirito, McGuinn, & Nobile, 2000), exploratory analyses included examining whether having asthma moderated this association in our urban sample. Based on past research (Koinis-Mitchell, Kopel, Boergers, McQuaid, et al., 2015; Koinis-Mitchell, Kopel, Boergers, Ramos, et al., 2015), we hypothesized that optimal sleep hygiene would be associated with longer sleep duration, higher levels of sleep efficiency, and less daytime sleepiness regardless of whether a child had asthma.

Methods

This analysis includes data from a larger study (R01 HD057220, Koinis-Mitchell, PI), which assessed the co-occurrence of asthma and allergic rhinitis symptoms, sleep quality, and academic functioning in urban school-aged children with and without persistent asthma.

Participants

Participants' families were recruited from four of the largest urban school districts in a Northeastern city, outpatient pediatric clinics, and a hospital-based asthma education program. Participants included 216 children with persistent asthma and 130 children without asthma. Eligible children were between the ages of 7 and 9 years, attended public school in one of the targeted districts, and had caregivers who self-identified as AA, Latino (Dominican or Puerto Rican), or NLW. Additionally, children in the asthma group were eligible if they met NHLBI (National Heart Lung and Blood Institute, 2007) criteria for persistent asthma (i.e., current asthma controller medication prescription, parent-reported recurrent daytime or nighttime symptoms, rescue medication use, at least two oral steroid bursts in the previous 12 months, or activity limitation). Exclusionary criteria for both groups included use of stimulant medication for attention deficit/hyperactivity disorder, moderate to severe cognitive impairment per school placement, another pulmonary or chronic health condition, or a diagnosed sleep disorder (e.g., chronic insomnia, obstructive sleep apnea). Approximately 2,800 potential participants were screened for eligibility, 81% of which were screened for inclusion in the asthma group, with the remainder screened for the control group. Twenty-four percent of those screened for the asthma group were deemed eligible, of which 55% ultimately enrolled in the study. Forty percent of those screened for the control group were eligible, of which 75% enrolled in the study. Eighty percent of both asthma and control participants completed the entire protocol. Overall, 22% of families preferred to complete the protocol in Spanish. For the larger study, a power analysis conducted using the Monte Carlo facility of Mplus V4.1, with 500 repetitions, determined that the sample would have sufficient power ($\geq$80%) to detect small effects (0.25) at a significance level of .05.

Procedures

Data were collected from August to December during one of the four study years (2010–2014). During the initial study visit, caregivers and children provided consent/assent, and caregivers provided demographic information. Caregivers in the asthma group confirmed children's medications. For the asthma group, the second research visit occurred at an asthma and allergy clinic. Study clinicians confirmed asthma diagnosis and evaluated disease severity and medication usage. Families of children without asthma completed this visit at our research offices. Sleep outcomes for all families were assessed during one 4-week home-monitoring period during which the child wore an actigraph to assess sleep duration and efficiency. The home monitoring period occurred during the fall and winter seasons (i.e., between the months of October and December). Average sleep duration and efficiency actigraphy data from this period were used for the current analyses. At a study visit (approximately halfway through the monitoring period), research staff administered sleep questionnaires (sleep hygiene, sleep environment, and daytime sleepiness) and downloaded and reviewed actigraphic sleep data. Study assessments were administered in English or Spanish according to each participant's preference. Research personnel were bilingual and standardized procedures (Canino & Bravo, 1994) were used for measure translation. Approval from the appropriate institutional review board was obtained.

Measures

Demographic Information

Caregivers provided demographic information (Table I). *Income-to-needs ratio* was determined by dividing the family's self-reported income by the U.S. federal per capita poverty threshold value for a family of their size during the study year (Duncan, Duncan, Hops, & Alpert, 1997; U.S. Department of Health and Human Services, 2014).

Neighborhood Risk

Neighborhood risk was determined using census block membership based on home address. A score of 1 was

Table I. *Sample Characteristics*

Characteristics	Sample	Asthma	No asthma	Group differences	Effect size
N	246	216	130		
Socio-contextual characteristics					
Child age in years, M (95% CI)	8.28 (8.19–8.37)	8.27 (8.16–8.39)	8.28 (8.15–8.42)	F (1,237) < 1.0	$\omega_p^2 < .01$
Male (%)	53.0	53.0	53.1	$X^2 < .01$	$\varphi < .01$
Caregiver race/ethnicity** (%)				X^2= 15.03**	$\varphi = .20$
Black	33.0	33.3	35.4		
Latino	45.1	51.0	33.8		
Non-Latino White	20.8	15.7	30.8		
Caregiver education, M_{yrs} (95% CI)					
Male head of the household	12.15 (11.79–12.50)	11.94 (11.48–12.40)	12.49 (11.94–13.05)	F (1,194) = 2.21	$\omega_p^2 < .01$
Female head of the household	12.50 (11.97–13.04)	12.30 (11.97–12.63)	12.92 (11.39–14.45)	F (1,358) = 1.12	$\omega_p^2 < .01$
Poor asthma control (%)		41			
Prescribed asthma controller meds (%)	–	74	–		
Use of daily asthma controller (%)	–	74.5			
Income-to-needs ratio*	0.99	0.90	1.08	F (1,351) = 6.96*	$\omega_p^2 = .02$
Neighborhood risk index, M (95% CI)	4.94	5.06	4.70	F (1,371) = 2.20	$\omega_p^2 < .01$
Total number of people in household	4.63 (4.46–4.80)	4.59 (4.41–4.87)	4.62 (4.37–4.85)	F (1,377) < 1.0	$\omega_p^2 < .01$
Sleep hygiene					
Total sleep hygiene,* M (95% CI)	4.51 (4.45–4.58)	4.49 (4.41–4.57)	4.63 (4.53–4.74)	F (1,339) = 4.53*	$\omega_p^2 = .01$
Physiological*	4.50 (4.41–4.61)	4.42 (4.31–4.57)	4.65 (4.48–4.82)	F (1,338) = 4.46*	$\omega_p^2 = .01$
Cognitive	3.40 (3.28–3.52)	3.31 (3.17–3.47)	3.55 (3.35–3.75)	F (1,338) = 3.50	$\omega_p^2 = .01$
Emotional	5.49 (5.41–5.57)	5.45 (5.35–5.55)	5.56 (5.43–5.69)	F (1,337) = 1.55	$\omega_p^2 < .01$
Environmental	5.34 (5.28–5.42)	5.33 (5.24–5.41)	5.39 (5.28–5.50)	F (1,339) = 1.10	$\omega_p^2 < .01$
Bedtime routine	3.74 (3.59–3.90)	3.68 (3.48–3.88)	3.86 (3.60–4.11)	F (1,337) = 1.09	$\omega_p^2 < .01$
Sleep stability	4.79 (4.71–4.87)	4.78 (4.69–4.89)	4.79 (4.66–4.93)	F (1,339) < 1.0	$\omega_p^2 < .001$
Sleep environment					
Shares a bed (%)	51.5	50.8	52.8	X^2= 0.82	$\varphi = .03$
Shares a bedroom (%)	36.9	35.4	39.7	X^2= 0.42	$\varphi = .04$
Sleep shifting (%)	25.5	27.8	21.0	X^2= 0.16	$\omega_p^2 < .001$
Neighborhood noises, M (95% CI)	1.39 (1.30–1.48)	1.45 (1.33–1.58)	1.27 (1.16–1.38)	F (1,339) = 3.55	$\omega_p^2 = .01$
Home noises,* M (95% CI)	1.41 (1.32–1.50)	1.49 (1.36–1.61)	1.27 (1.17–1.38)	F (1,339) = 5.37*	$\omega_p^2 = .02$
Sleep outcomes					
Sleep duration, M (95% CI)	9.27 (9.20–9.34)	9.26 (9.18–9.34)	9.29 (9.18–9.40)	F (1,323) < 1.0	$\omega_p^2 < .01$
Sleep efficiency,** M (95% CI)	87.00 (86.63–87.37)	86.57 (86.08–87.06)	87.81 (87.29–88.33)	F (1,323) = 10.15**	$\omega_p^2 = .03$
Daytime sleepiness,** M (95% CI)	13.56 (13.21–13.92)	14.09 (13.64–14.54)	12.44 (11.91–12.96)	F (1,320) = 19.11**	$\omega_p^2 = .06$

*$p \leq .05$; ** $p \leq .01$.

assigned for the following characteristics: (1) family income less than one-third the national average; (2) >29% of adults did not complete high school; (3) >9% of adults were unemployed; (4) >27% of adults were non-English speaking; (5) <50% NLWs; (6) >10% vacant housing; (7) >22% small housing units; (8) >15% of families below poverty threshold. The cutoff points represent the 25% poorest census block groups of each indicator. Higher scores indicate more risk. This index has been associated with asthma outcomes (e.g., asthma management and morbidity) in urban children (Canino, McQuaid, & Rand, 2009; Koinis-Mitchell, Kopel, Boergers, McQuaid, et al., 2015).

Asthma Classification and Control

Each asthma participant underwent a physical examination, allergy skin testing, and pulmonary function testing. A study clinician confirmed asthma severity, and all children met criteria for mild, moderate, or severe persistent asthma using NHLBI Expert Panel Report - 3 guidelines (National Heart Lung and Blood Institute, 2007). Parents and children completed the Asthma Control Test (Liu et al., 2007), and a score above 19 indicated well-controlled asthma (Nathan et al., 2004).

Asthma Medication Adherence

Current daily use of asthma controller medication and asthma medication adherence were documented using the Family Asthma Management System Scale (FAMSS; McQuaid, Walders, Kopel, Fritz, & Klinnert, 2005), which is a semi-structured interview used to assess asthma management and scored by trained interviewers using a 1 (*poor*) to 9 (*optimal*) score. Asthma management ratings from the FAMSS have demonstrated convergent validity in diverse pediatric samples (Celano, Klinnert, Holsey, & McQuaid, 2011; McQuaid et al., 2005).

Sleep Hygiene

Caregivers completed the Children's Sleep Hygiene Scale (CSHS; Harsh, Easley, & LeBourgeois, 2002). This measure includes items that assess physiological (e.g., consumption of food/beverage before bed), cognitive (e.g., engagement in stimulating activities), emotional (e.g., feeling upset before bed), environmental (e.g., bothered by light in the bedroom), bedtime routine (e.g., engagement in a consistent routine), and sleep stability (e.g., maintenance of consistent sleep/wake schedule) factors associated with sleep hygiene. The CSHS has been used in children with (Koinis-Mitchell, Kopel, Boergers, McQuaid, et al., 2015) and without (Harsh et al., 2002; Witcher et al., 2012) asthma, and in urban samples (Koinis-Mitchell, Kopel, Boergers, McQuaid, et al., 2015). Internal consistency for the full scale was acceptable for the asthma ($\alpha = .72$) and no asthma ($\alpha = .68$) groups.

Sleep Environment

Caregivers completed the General Sleep Inventory (Hale, Berger, LeBourgeois, & Brooks-Gunn, 2009). Caregivers indicated whether their child (1) shares a bedroom, (2) shares a bed, (3) falls asleep in his/her bed versus another room (i.e., sleep shifting), and (4) how often (i.e., Likert-type scale from *never* to *always*) they are disturbed by home and/or neighborhood noises. In addition, caregivers indicated how many people live in the home.

Sleep Outcomes

Sleep duration and *sleep efficiency* was assessed with an actigraph, which is a wearable device that quantifies sleep/wake patterns (Actiwatch 2; Philips Respironics, Pittsburgh, PA, USA). Children wore the actigraph on their nondominant hand at all times except when bathing or swimming. To inform scoring of the sleep data, families recorded instances when the child was sick with an illness other than asthma, morning wake times and evening bedtimes, and times when the actigraph was not worn (Acebo et al., 1999). One-minute epochs (i.e., time periods) were estimated as sleep or wakefulness, with Actiware-Sleep V 2.53 software using activity levels produced in the surrounding 2-min interval and actigraph event markers set by participants at "lights-off" and "lights-on." Standard scoring rules were then applied to each sleep episode (Acebo et al., 1999; Koinis-Mitchell, Kopel, Boergers, McQuaid, et al., 2015). Families had to be adherent with study procedures for 7 days. Actigraphy data from adherent families were collected across week and weekend nights and were included if at least five consecutive days (Acebo et al., 1999) of data were available. Nighttime sleep episodes were collected. Episodes were excluded when (1) the concurrent diary report was not available, (2) the actigraph was off for all/part of the sleep period, (3) diary indicated illness other than asthma that could have affected sleep on a given night, or (4) when all/part of the sleep period included external motion (e.g., sleeping in a car) (Koinis-Mitchell, Kopel, Boergers, McQuaid, et al., 2015). Overall, 85% of asthma cases and 87% of control cases that were eligible for the larger study had valid actigraphy data and were included in the current study. Actigraphy data were not available for 21 children due to protocol nonadherence. There were no differences between those with and without sleep data on demographic characteristics. Data were available for 325 children, and an average of 18 nights were scorable ($SD = 7.43$, range = 5–40). *Sleep duration* was defined as the total time between evening sleep onset and morning waking, and *sleep efficiency* was defined as percent of time asleep/total time in bed (Acebo et al., 2005; Koinis-Mitchell, Kopel, Boergers, McQuaid, et al., 2015).

Daytime sleepiness was assessed using the Daytime Sleepiness subscale of the Children's Sleep Habits Questionnaire (CSHQ; Owens et al., 2000). Caregivers completed this measure, and subscale items assessed indicators of daytime sleepiness (e.g., seems tired) and are rated on a Likert-type scale (*rarely* = 0–1 per week; *sometimes* = 2–4 per week; *usually* = 5–7 per week). The CSHQ has been used in healthy and chronic-illness samples and has demonstrated good reliability and content validity (Bursztein, Steinberg, & Sadeh, 2006; Koinis-Mitchell, Kopel, Boergers, Ramos, et al., 2015; Owens et al., 2000). Internal consistencies for this scale were poor to questionable for the no asthma ($\alpha = .48$) and asthma ($\alpha = .52$) groups. As such, readers should be conservative in their interpretation of the daytime sleepiness results. Higher scores on this measure indicate more frequent daytime sleepiness.

Data Analyses

Preliminary analyses to identify group differences (asthma vs. no asthma) on demographic (i.e., sex, race/ethnicity) and sleep variables (i.e., sleep hygiene, sleep duration, sleep efficiency, and daytime sleepiness) were conducted with analysis of variance (ANOVA) or chi-square analyses. Associations between continuous demographic (i.e., age), urban stressors (i.e., neighborhood risk and income-to-needs), and sleep variables were evaluated with correlation analyses. Demographic variables associated with both independent and dependent variables were included as covariates in subsequent analyses.

We used ANOVAs to examine whether sleep hygiene scores differed between children with and without asthma. Next, we used chi-square tests and ANOVAs to evaluate aspects of the sleep environment between groups. Given ethnic disparities known to exist in children with asthma, ANOVAs were conducted to examine ethnic differences in sleep hygiene and sleep outcomes in children with and without asthma. To determine whether differences existed when controlling for urban stressors, analyses of covariance (ANCOVAs) were conducted. Neighborhood risk was significantly associated with families' income-to-needs ratio and sleep indicators (i.e., sleep hygiene, sleep duration), and is a multidimensional indicator of urban risk factors. As such, neighborhood risk was used as a proxy for urban stress in these ANCOVA analyses.

To examine whether having asthma predicted sleep hygiene beyond level of neighborhood risk, we conducted a hierarchical regression. Neighborhood risk was entered in the first step, and asthma status was entered in the second step. There were no relevant demographic covariates for these analyses.

To examine the effect of sleep hygiene on each sleep outcome and whether these effects were similar in our sample of children with and without asthma, three moderation analyses were conducted. Demographic covariates and neighborhood risk were entered in the first step of the hierarchical regression, sleep hygiene and asthma status were entered in the second step, and the sleep hygiene by asthma status interaction term was entered in the third step. Post hoc probing was then conducted using simple slope analyses to examine the conditional effects. A Bonferroni-adjusted alpha level of .0167 per test was used for these analyses.

Normality tests revealed that daytime sleepiness was positively skewed and neighborhood risk was negatively skewed. Relevant analyses were repeated with log-transformed variables and did not yield different results; hence, analyses with untransformed variables are reported. All analyses were conducted using SPSS version 23.0. Effect sizes for hierarchical regression analyses are presented as R^2_{adjusted}. Chi-square effect sizes are expressed as Cramer's Phi (φ), which is similar to a point-biserial correlation. Effect sizes for analyses of variance are expressed as partial omega squared (ω_p^2), interpreted as small (0.01), medium (0.06), or large (0.14; Cohen & Williamson, 1998).

Results

Preliminary Analyses Results

Table I describes the socio-contextual characteristics of the 216 children with persistent asthma and the 130 children without asthma. Fifteen percent of children with asthma and 13% of children without asthma had missing objective sleep data. Cases for which children did not have subjective and objective sleep data were removed. The majority of participants in the current study had complete data on all measures for the current study, and factors accounting for missing data were not differentially present in the two groups. There were several reasons why children could have not had scorable sleep data during the monitoring period including that: (1) the actigraph was not worn for all/part of night, or (2) there was insufficient information to determine sleep onset and sleep offset; hence, the night could not be scored. Each of these possible scenarios was considered and reviewed during research team consensus meetings. The majority of participants in current study had complete data on all measures for the current study. Thus, we did not need to impute missing data strategies (e.g., impute means).

With regard to preliminary correlational analyses, only significant results are reported. In the whole sample, age, income-to-need ratio, and neighborhood risk were associated with sleep hygiene (r's = −.13, .25, −.18, respectively, p's < .05) and sleep duration (r's = −.26, .17, −.13, respectively, p's < .05). Girls had higher levels of sleep efficiency ($F(1, 316) = 7.71$, $p < .01$) and daytime sleepiness ($F(1, 320) = 4.53$, $p = .03$). Children with asthma had poorer sleep efficiency and higher levels of daytime sleepiness (Table I). Neighborhood risk was moderately negatively correlated with income-to-needs ratio ($r = -.41$, $p < .001$), and thus, neighborhood risk was used as a proxy for urban stress and is referred to as such in subsequent analyses and results.

In children with asthma, sleep hygiene, sleep duration, sleep efficiency, and daytime sleepiness did not differ by asthma severity or by use of asthma controller medication. Asthma controller medication adherence was also not associated with sleep hygiene, sleep duration, sleep efficiency, or daytime sleepiness. Sleep hygiene, sleep duration, and daytime sleepiness did not differ by asthma control, but children with poorly controlled asthma had poorer sleep efficiency ($F(1, 194) = 8.78$, $p = .001$).

Examination of ethnic differences in sleep hygiene and sleep outcomes revealed that, in children with asthma, NLW children had more optimal sleep hygiene than Latino children and longer sleep duration

Table II. *Ethnic Group Differences in Children With and without Asthma*

Characteristics of sample	Black	Latino	Non–Latino White	Group differences	Effect sizes
Children with asthma					
N	83	127	39		
Urban contextual stressors					
Income to needs ratio	0.93	0.67	1.60	F (2,235) = 17.54**	$\omega_p^2 = .13$
Neighborhood risk index**, *M* (95%)	5.23 (4.77–5.69)[a]	5.58 (5.29–5.87)[a]	3.05 (2.28–3.83)[b]	F (2,244) = 25.90**	$\omega_p^2 = .18$
Total number of people in household	4.53 (4.08–4.98)	4.69 (4.41–4.96)	4.41 (3.96–4.86)	F (2,246) = .45	$\omega_p^2 < .00$
Sleep hygiene, *M* (95% CI)	4.47 (4.34–4.60)[a,b]	4.45 (4.34–4.55)[a]	4.72 (4.52–4.91)[b]	F (2,217) = 3.15*	$\omega_p^2 = .03$
Sleep outcomes					
Sleep duration**, *M* (95% CI)	9.27 (9.13–9.40)[a]	9.14 (9.04–9.24)[a]	9.64 (9.18–9.34)[b]	F (2,209) = 9.64**	$\omega_p^2 = .08$
Sleep efficiency, *M* (95% CI)	85.79 (84.93–86.64)	86.92 (86.24–87.60)	87.13 (85.87–88.38)	F (2,209) = 2.61	$\omega_p^2 = .02$
Daytime sleepiness, *M* (95% CI)	14.53 (13.77–15.24)	14.18 (13.38–14.78)	12.85 (11.70–13.68)	F (2,216) = 3.00	$\omega_p^2 = .03$
Children without asthma					
N	46	44	40		
Urban contextual stressors					
Income to needs ratio	0.92[a]	0.77[b]	2.0[c]	F (2,112) =18.18**	$\omega_p^2 = .25$
Neighborhood risk index**, *M* (95%)	5.39 (4.77–5.60)[a]	5.33 (4.65–6.00)[a]	3.23 (2.41–4.05)[b]	F (2,123) =12.02**	$\omega_p^2 = .16$
Total number of people in household	4.65 (4.21–5.10)	4.64 (4.21–5.06)	4.53 (4.13–4.92)	F (2,127) = .10	$\omega_p^2 < .00$
Sleep hygiene, *M* (95% CI)	4.61 (4.44–4.79)	4.59 (4.41–4.78)	4.70 (4.50–4.90)	F (2,118) <1.0	$\omega_p^2 = .01$
Sleep outcomes					
Sleep duration, *M* (95% CI)	9.16 (8.95–9.37)	9.26 (9.05–9.47)	9.45 (9.30–9.60)	F (2,110) = 2.48	$\omega_p^2 = .04$
Sleep efficiency, *M* (95% CI)	87.79 (86.84–88.74)	88.41 (87.59–89.24)	87.23 (86.27–88.19)	F (2,110) = 1.69	$\omega_p^2 = .03$
Daytime sleepiness**, *M* (95% CI)	13.14[a] (12.42–14.20)	12.80[a] (12.02–13.98)	11.30[b] (10.35–12.09)	F (2,100) = 4.84**	$\omega_p^2 = .09$

*$p \leq .05$; ** $p \leq .01$.
[a,b,c]Means that have no superscript in common are significantly different from each other.

than AA and Latino children (Table II). However, when controlling for urban stress, sleep hygiene behaviors did not differ across ethnic groups (F (3, 215) = 1.04, p = .36). Sleep duration differences were maintained across ethnic groups when controlling for urban stress (F (3, 205) = 8.77, p < .001). In children without asthma, NLW children reported less daytime sleepiness than AA and Latino children (Table II), and this difference continued when controlling for urban stress (F (3, 95) = 3.53, p = .03). No ethnic differences existed in sleep efficiency in children with and without asthma (Table II). Considering the impact of urban stressors on ethnic differences when examining sleep hygiene, ethnicity was not controlled for in subsequent analyses.

Primary Aims Results

Sleep Hygiene and Sleep Environment in Children With and Without Asthma

Children without asthma had more optimal physiologically based sleep hygiene behaviors and overall sleep hygiene than those with asthma (Table I); however, after controlling for level of urban stress, total and physiological sleep hygiene scores did not differ across groups (F (2, 333) = 3.47, F (2, 332) = 3.44, p's > .05, respectively).

No group differences were found in bed sharing, bedroom sharing, sleep shifting, number of people living in the home, and neighborhood noise disturbance (Table I). Children with asthma were more frequently disturbed by noises in the home, and this difference persisted when controlling for urban stress (F (2, 333) = 5.80, p = .02) and the number of people living in the home (F (2, 338) = 5.36, p = .02). In children without asthma, more frequent noise disturbance in the home was associated with lower levels of sleep efficiency (r = −.26, p = .01), but was not associated with sleep duration or daytime sleepiness. Disturbance from noises in the home was not associated with sleep outcomes in children with asthma.

Asthma, Urban Stress, and Sleep Hygiene

A hierarchical regression analysis was conducted to examine whether asthma was associated with sleep

Table III. *Association Between Sleep Hygiene and Sleep Outcomes in Children With and Without Asthma*

Sleep hygiene and sleep outcomes	*B*	*β*	*t*	95% CI	R^2 adj	ΔR^2
Sleep duration						
Block 1					.01*	.02*
Neighborhood risk	−2.02	−.13	−2.32*	−3.74 – −.30		
Block 2					.05**	.04**
Neighborhood risk	−1.46	−.09	−1.67	−3.184 – .26		
Asthma (0 = No asthma)	1.15	.02	0.28	−6.94 – 9.25		
Sleep hygiene	12.34	.20	3.60**	5.62 – 19.15		
Block 3					.05	.002
Neighborhood risk	−1.45	−.09	−1.65	−3.17 – 0.28		
Asthma (0 = no asthma)	0.60	.01	0.14	−7.63 – 8.84		
Sleep hygiene	9.13	.15	1.62	−1.96 – 20.22		
Asthma × Sleep hygiene	1.16	.07	0.73	−1.97 – 4.30		
Sleep efficiency	*B*	*β*	*t*	95% CI	R^2 adj	ΔR^2
Block 1					.02*	.02*
Neighborhood risk	−0.02	−.01	−0.22	−0.18 – 0.15		
Child sex	1.00	.15	2.62**	0.25 – 1.75		
Block 2					.04**	.03**
Neighborhood risk	0.02	.01	0.17	−0.15 – 0.18		
Child sex	0.98	.14	2.60**	0.24 – 1.73		
Asthma (0 = No asthma)	−1.23	−.17	−3.10**	−2.02 – −0.45		
Sleep hygiene	0.17	.03	0.51	−0.49 – 0.83		
Block 3					.04	.002
Neighborhood risk	0.02	.09	0.19	−0.15 – 0.18		
Child sex	1.01	.15	2.66**	0.26 – 1.76		
Asthma (0 = no asthma)	−1.29	−.18	−3.19**	−2.09 – −0.49		
Sleep hygiene	9.13	.15	−0.32	−1.26 – 0.91		
Asthma × Sleep hygiene	0.12	.07	0.79	−0.18 – 0.43		
Daytime sleepiness	*B*	*β*	*t*	95% CI	R^2 adj	ΔR^2
Block 1					.01*	.02
Neighborhood risk	0.09	.06	1.07	−0.07 – 0.25		
Child sex	0.83	.13	2.25*	0.11 – 1.56		
Block 2					.21**	.20**
Neighborhood risk	−0.04	−.03	−0.60	−0.19 – 0.10		
Child sex	1.01	.16	3.05**	0.36 – 1.67		
Asthma (0 = no asthma)	1.35	.19	3.75**	0.64 – 2.05		
Sleep hygiene	−2.24	−.40	−7.66**	−2.82 – −1.67		
Block 3					.21	.003
Neighborhood risk	0.05	−.03	−0.62	−0.19 – 0.10		
Child sex	0.98	.15	2.94**	0.32 – 1.64		
Asthma (0 = no asthma)	1.41	.20	3.87**	0.69 – 2.13		
Sleep hygiene	−1.81	−.32	−3.64**	−2.78 – −0.83		
Asthma × Sleep hygiene	−0.15	−.09	−1.09	−0.42 – 0.12		

$p \leq .05$; ** $p \leq .01$.

hygiene beyond urban stress. Results indicated that having asthma did not predict overall sleep hygiene when controlling for urban stress (β = .10, *SE* = .07, *p* = .06), with higher levels of urban stress predicting poorer sleep hygiene (β = −.17, SE = .01, *p* < .01).

Moderation Effects of Asthma and Sleep Hygiene on Sleep Outcomes

Next, hierarchical regression analyses were conducted to examine whether the effect of sleep hygiene on sleep duration, sleep efficiency, and daytime sleepiness was moderated by asthma status. Urban stress was entered in the first step of each regression model. In addition, sleep efficiency and daytime sleepiness differed by child sex, so sex was entered into the first step with urban stress for these outcomes. For sleep duration, there was a main effect of sleep hygiene on sleep duration; however, when the interaction term was added, sleep hygiene no longer predicted sleep duration (Table III). Moderation probing indicated that there was a significant conditional effect of more optimal sleep hygiene predicting longer sleep duration for children with asthma (*B* = 14.24, *p* = .001), but there was no effect in children without asthma (*B* = 8.89, *p* > .05).

Sleep hygiene and child sex significantly predicted sleep efficiency, but the sleep hygiene by asthma status interaction was not associated with efficiency (Table III) and there were no conditional effects of sleep hygiene on sleep efficiency for both children with and without asthma ($B = .33$, $B = -.13$, p's $> .05$, respectively). More optimal sleep hygiene predicted lower levels of daytime sleepiness similarly for both children with and without asthma (Table III).

Discussion

The current study builds on prior work by using both objective and subjective methods to assess the sleep environment, sleep hygiene behaviors, and sleep outcomes in a large, carefully evaluated urban sample of children with and without chronic illness. Contrary to our expectation that having asthma may have challenged optimal sleep hygiene, sleep hygiene was similar in both groups when controlling for level of urban stress. Urban stress factors more common in an urban setting, such as household noise and crowded housing, as opposed to the presence or absence of asthma, may make it more difficult for urban children and families to implement consistent and adaptive sleep hygiene behaviors.

Further, minimal differences in the sleep environment were found across urban families of children with and without asthma in our sample. Children with asthma were more frequently disturbed by noises in the home during sleep, and this difference was found even when controlling for level of urban stress and number of people living in the home. Children with persistent asthma may be more likely to be awakened due to nocturnal symptoms (Chugh et al., 2006; Koinis-Mitchell et al., 2012), which may increase their awareness of noise in the home. Moreover, caregivers of children with asthma may more closely monitor their children at night, which may increase awareness of potential noise.

Consistent with the pediatric sleep literature (Mindell et al., 2009), optimal sleep hygiene behaviors were associated with one or more sleep outcomes in both groups of our sample even when controlling for urban stress. Within this urban sample, average sleep duration (9.27 hr) was lower than recommended guidelines for this age-group (10.5–11 hr per night; Mindell & Owens, 2015). Further, sleep hygiene scores were both similar to (LeBourgeois, Giannotti, Cortesi, Wolfson, & Harsh, 2005) and lower than (Zafar, Ness, Dowdy, Avis, & Bashir, 2012) nonurban samples of children without chronic illness. More optimal sleep hygiene behaviors were related to less daytime sleepiness in children with asthma, but sleep hygiene was only related to longer sleep duration in children with asthma. Sleep hygiene was not associated with sleep efficiency in either of our sample groups. However, having asthma was associated with poorer sleep efficiency and more daytime sleepiness. Poorer sleep quality is common in children with asthma due to the presence of nocturnal symptoms (Koinis-Mitchell, Kopel, Boergers, McQuaid, et al., 2015; Mitchell & Everhart, 2013); thus, nocturnal asthma may be more directly linked to sleep quality than to sleep hygiene behaviors. Children with asthma also had higher levels of daytime sleepiness, which may be related to poorer sleep quality secondary to nocturnal asthma symptoms. Although asthma severity and management were not related to daytime sleepiness in the asthma group of our sample, levels of daytime sleepiness may also be attributed to nocturnal asthma-related factors not assessed in the current study (e.g., cytokine production and inflammation). Sleep hygiene and sleep quality may be challenged by asthma management behaviors or vice versa, but these associations along with consideration of disease severity mediators need to be further examined in future work.

NLW children in our sample had more optimal sleep hygiene, longer sleep duration, and less daytime sleepiness relative to Latino and AA participants, which is consistent with other studies demonstrating ethnic health disparities in sleep outcomes (Crosby et al., 2005; Spilsbury et al., 2004). In the current study, however, some of these differences disappeared when accounting for neighborhood risk, suggesting perhaps that urban stressors play a more central role in sleep hygiene practices. For urban children with asthma in our sample, ethnic differences in sleep duration persisted even when controlling for level of urban stress, which suggests an ethnic disparity that has not been demonstrated to date by prior work. Future research should examine factors potentially related to ethnic differences in sleep outcomes (i.e., cultural beliefs, stressors related to ethnic background; Boergers & Koinis-Mitchell, 2010)

To our knowledge, the current study is the first to examine sleep hygiene, aspects of the sleep environment, and sleep outcomes in a large, diverse sample of urban children with and without asthma; however, limitations should be noted. First, we acknowledge the multidimensional nature of sleep health (Buysse, 2014) and future work would benefit from examining additional sleep indicators (e.g., sleep quality, sleep timing). Second, within our urban sample, the daytime sleepiness measure did not demonstrate adequate internal consistency and results using this measure should be interpreted with caution. Although associations between sleep hygiene and daytime sleepiness were in expected directions, future work is needed to further assess the reliability of this measure in urban, school-aged samples. In addition, this study may have been underpowered to conduct the current interaction analyses. Third, although we collected sleep duration data over multiple nights via actigraphy, an average sleep duration variable was used, thus limiting the ability to test longitudinal, causal effects. Even though we used standardized procedures for scoring and collecting objective sleep data within a large sample, valid actigraph sleep data were missing for some participants, and those participants were not included in the current sample. We acknowledge that this is a limitation, and although missing objective data did not differ across groups, this may introduce a source of bias. Further, it was beyond the scope of this study to conduct separate analyses for weekday and weekend nights. Future work would benefit from examining associations among sleep hygiene behavior and sleep outcomes on weekend and weekday nights. Fourth, we used a multidimensional measure of sleep hygiene but recognize that using additional objective approaches (e.g., environmental capture systems; Kay et al., 2012) would strengthen understanding of our observed associations in children with and without chronic illnesses. Sleep data were collected during the same 2-month period in the fall and winter to control for seasonal effects across participants; however, we acknowledge that allergy-related seasonal changes may influence asthma symptom patterns, thus affecting sleep outcomes. Shorter daylight duration during the study period may have also influenced circadian processes, melatonin secretion, and ultimately sleep onset and duration. Future work would benefit from collecting longitudinal data throughout the year to confirm associations among sleep hygiene and sleep outcomes in urban children.

Moreover, we acknowledge that other indicators of urban stress not assessed in this study (e.g., level of home/neighborhood noise, neighborhood crime, number of beds in the home) may also affect sleep behaviors and future work would benefit from including multiple subjective and objective measurements of urban environmental factors. Although inclusion of an examination of neighborhood risk and income-to-needs ratio allowed for a broader assessment of urban stress, future research should investigate additional indicators of SES (e.g., perception of poverty, level of crime) that may also be implicated in sleep outcomes (Boergers & Koinis-Mitchell, 2010). To control for developmental differences in sleep hygiene and outcomes, the study included only 7–9-year-old children. Thus, these research questions need to be examined in larger samples including a wider age range of children, as the current results may not generalize to children in other age groups. The examination of comorbid conditions (e.g., obesity, psychological conditions) and children's nutrition, including sugar and caffeine consumption, also warrants further investigation given their relevance to sleep and asthma (Kopel et al., 2010, 2016).

The current study highlights the importance of considering urban contextual stressors when assessing sleep hygiene and sleep outcomes in urban children. Further, the current urban sample had poorer sleep outcomes (e.g., sleep duration) and sleep hygiene behaviors as compared with nonurban samples, suggesting that urban children may be particularly vulnerable to poor outcomes and represent an at-risk group. Given that sleep hygiene is an important factor in overall sleep health and sleep health is implicated in biological, cognitive, and psychological functioning, targeted clinical assessments are warranted for this at-risk group.

Specifically, pediatric sleep evaluations and treatment recommendations should take into account specific urban risk factors, which may negatively affect sleep and should distinguish between which strategies are within (e.g., feasible adjustments to the sleep routine) and beyond (e.g., crowded housing) a family's ability to control. Clinicians may also need to consider the family's living conditions and other social determinants (e.g., housing instability, parental education; Klein et al., 2011; Zuckerman, 2014) that may serve as barriers to following recommendations. Along with the assessment of these social factors, clinicians should also consider querying families on aspects of the household (e.g., bedrooms/beds/individuals) and caregiver and other family members' evening schedules to guide sleep recommendations. These questions may be useful to include in intake forms to help assess the family's needs and guide more appropriate recommendations (e.g., same-aged children with similar bedtimes can be paired together, or family members who are home at bedtime or who sleep with the child can be integrated into recommendations). Sleep hygiene recommendations should also be tailored to the age of the child. For example, recommendations for school-aged children may need to address bedtime resistance and how to implement a consistent, calming bedtime routine, whereas interventions for adolescents may need to focus on eliminating exposure to screens before bed.

Further, urban children with chronic illness, such as asthma, may have additional, unique sleep health needs. Urban stressors may affect sleep hygiene behaviors, and asthma management behaviors and disease-related symptoms may influence sleep quality. Thus, future work is needed to develop and examine integrated asthma and sleep interventions that are sensitive to urban stresses and focus both on sleep hygiene behaviors and appropriate asthma control (e.g., education and behavioral management surrounding medication adherence as well as use of and availability of rescue inhaler before/during bedtime, if needed), which may decrease asthma morbidity and enhance sleep health in this high-risk group.

Collectively, results within our urban sample highlight the importance of considering urban context when assessing sleep hygiene behaviors and sleep outcomes in children with and without asthma. Poorer sleep quality is common in children with asthma as was evident within our sample; however, the current findings indicate that contextual (e.g., urban stress) and behavioral (e.g., sleep hygiene) factors also play an important role in sleep health outcomes. Thus, it is essential to consider interrelations among asthma symptomatology, urban stressors, and sleep hygiene behaviors when addressing sleep health in urban pediatric populations.

Funding

This work is supported by National Institutes of Health, the Eunice Kennedy Shriver National Institute of Child Health and Human Development (R01 HD057220; PI, Koinis-Mitchell).

Conflicts of interest: None declared.

References

Acebo, C., Sadeh, A., Seifer, R., Tzischinsky, O., Hafer, A., & Carskadon, M. A. (2005). Sleep/wake patterns derived from activity monitoring and maternal report for healthy 1-to 5-year-old children. *Sleep*, *28*, 1568–1577.

Acebo, C., Sadeh, A., Seifer, R., Tzischinsky, O., Wolfson, A. R., Hafer, A., & Carskadon, M. A. (1999). Estimating sleep patterns with activity monitoring in children and adolescents: How many nights are necessary for reliable measures? *Sleep*, *22*, 95–103.

Boergers, J., & Koinis-Mitchell, D. (2010). Sleep and culture in children with medical conditions. *Journal of Pediatric Psychology*, *35*, 915–926.

Bursztein, C., Steinberg, T., & Sadeh, A. (2006). Sleep, sleepiness, and behavior problems in children with headache. *Journal of Child Neurology*, *21*, 1012–1019.

Buysse, D. J. (2014). Sleep health: can we define it? Does it matter. *Sleep*, *37*, 9–17.

Canino, G., & Bravo, M. (1994). The adaptation and testing of diagnostic and outcome measures for cross-cultural research. *International Review of Psychiatry*, *6*, 281–286.

Canino, G., Garro, A., Alvarez, M. M., Colón-Semidey, A., Esteban, C., Fritz, G., others. (2012). Factors associated with disparities in emergency department use among Latino children with asthma. *Annals of Allergy, Asthma and Immunology*, *108*, 266–270.

Canino, G., Koinis-Mitchell, D., Ortega, A. N., McQuaid, E. L., Fritz, G. K., & Alegría, M. (2006). Asthma disparities in the prevalence, morbidity, and treatment of Latino children. *Social Science and Medicine*, *63*, 2926–2937.

Canino, G., McQuaid, E. L., & Rand, C. S. (2009). Addressing asthma health disparities: a multilevel challenge. *Journal of Allergy and Clinical Immunology*, *123*, 1209–1217.

Celano, M., Klinnert, M. D., Holsey, C. N., & McQuaid, E. L. (2011). Validity of the family asthma management system scale with an Urban African-American sample. *Journal of Pediatric Psychology*, *36*, 576–585. https://doi.org/10.1093/jpepsy/jsp083

Chugh, I. M., Khanna, P., & Shah, A. (2006). Nocturnal symptoms and sleep disturbances in clinically stable asthmatic children. *Asian Pacific Journal of Allergy and Immunology*, *24*, 135.

Cohen, S., & Williamson, G. M. (1998). Perceived stress in a probability sample of the United States. In S. Oskamp & S. Spacapan (Eds.), *The social psychology of health* (pp. 31–67). Thousand Oaks, CA: Sage Publications.

Crosby, B., LeBourgeois, M. K., & Harsh, J. (2005). Racial differences in reported napping and nocturnal sleep in 2-to 8-year-old children. *Pediatrics*, *115(Suppl 1)*, 225–232.

Daniel, L. C., Boergers, J., Kopel, S. J., & Koinis-Mitchell, D. (2012). Missed sleep and asthma morbidity in urban children. *Annals of Allergy, Asthma and Immunology*, *109*, 41–46.

Duncan, T. E., Duncan, S. C., Hops, H., & Alpert, A. (1997). Multi-level covariance structure analysis of intrafamilial substance use. *Drug and Alcohol Dependence*, *46*, 167–180.

El-Sheikh, M., Bagley, E. J., Keiley, M., Elmore-Staton, L., Chen, E., & Buckhalt, J. A. (2013). Economic adversity and children's sleep problems: Multiple indicators and moderation of effects. *Health Psychology*, *32*, 849.

Gabe, T. (2013). *Poverty in the United States: 2012. Congressional research service report to Congress.* Washington, DC: Congressional Research Service.

Gruchalla, R. S., Pongracic, J., Plaut, M., Evans, R., Visness, C. M., Walter, M., others. (2005). Inner City Asthma Study: relationships among sensitivity, allergen exposure, and asthma morbidity. *Journal of Allergy and Clinical Immunology*, *115*, 478–485.

Hale, L., Berger, L. M., LeBourgeois, M. K., & Brooks-Gunn, J. (2009). Social and demographic predictors of preschoolers' bedtime routines. *Journal of Developmental and Behavioral Pediatrics*, *30*, 394–402. https://doi.org/10.1097/DBP.0b013e3181ba0e64

Harsh, J. R., Easley, A., & LeBourgeois, M. K. (2002). A measure of children's sleep hygiene. *Sleep*, *25*, A316.

Kay, M., Choe, E. K., Shepherd, J., Greenstein, B., Watson, N., Consolvo, S., & Kientz, J. A. (2012). Lullaby: A capture & access system for understanding the sleep environment.In *Proceedings of the 2012 ACM conference on ubiquitous computing* (pp. 226–234). ACM. Retrieved from http://dl.acm.org/citation.cfm?id=2370253

Kieckhefer, G. M., Ward, T. M., Tsai, S. Y., & Lentz, M. J. (2008). Nighttime sleep and daytime nap patterns in school age children with and without asthma. *Journal of Developmental and Behavioral Pediatrics*, *29*, 338–344. https://doi.org/10.1097/DBP.0b013e318182a99e

Klein, M. D., Kahn, R. S., Baker, R. C., Fink, E. E., Parrish, D. S., & White, D. C. (2011). Training in social determinants of health in primary care: Does it change resident behavior? *Academic Pediatrics*, *11*, 387–393.

Koinis-Mitchell, D., Craig, T., Esteban, C. A., & Klein, R. B. (2012). Sleep and allergic disease: A summary of the literature and future directions for research. *Journal of Allergy and Clinical Immunology*, *130*, 1275–1281.

Koinis-Mitchell, D., & Everhart, R. (2013). Asthma, Allergies, and Sleep. In A. R. *Wolfson & H. E. Montgomery-Downs (Eds.), The Oxford Handbook of*

Infant, Child, and Adolescent Sleep and Behavior (pp. 457–470). New York, NY: Oxford University Press.

Koinis-Mitchell, D., Kopel, S. J., Boergers, J., McQuaid, E. L., Esteban, C. A., Seifer, R. … & LeBourgeois, M. (2015). Good sleep health in Urban children with asthma: A risk and resilience approach. *Journal of Pediatric Psychology*, 1–13.

Koinis-Mitchell, D., Kopel, S. J., Boergers, J., Ramos, K., LeBourgeois, M., McQuaid, E. L. … & Klein, R. (2015). Asthma, allergic rhinitis, and sleep problems in urban children. *Journal of Clinical Sleep Medicine*, *11*, 101–110.

Koinis-Mitchell, D., McQuaid, E. L., Kopel, S. J., Esteban, C. A., Ortega, A.N., Seifer, R. … & Fritz, G. K. (2010). Cultural-related, contextual, and asthma-specific risks associated with asthma morbidity in urban children. *Journal of Clinical Psychology in Medical Settings*, *17*, 38–48.

Koinis-Mitchell, D., McQuaid, E. L., Seifer, R., Kopel, S. J., Esteban, C., Canino, G. … & Fritz, G. K. (2007). Multiple urban and asthma-related risks and their association with asthma morbidity in children. *Journal of Pediatric Psychology*, *32*, 582–595.

Kopel, S. J., McQuaid, E. L., Boergers, J., Esteban, C., Seifer, R., Fritz, G. K. … & Mitchell, D. K. (2016). Asthma-related co-morbidities in Urban children with persistent asthma: Contributors to disparities in asthma, sleep and academic outcomes. *Respiratory and Critical Care Medicine*, A6430–A6430.

Kopel, S. J., Walders-Abramson, N., McQuaid, E. L., Seifer, R., Koinis-Mitchell, D., Klein, R. B.… & Fritz, G. K. (2010). Asthma symptom perception and obesity in children. *Biological Psychology*, *84*, 135–141. https://doi.org/10.1016/j.biopsycho.2009.11.007

Kurth, S., Olini, N., Huber, R., & LeBourgeois, M. (2015). Sleep and early cortical development. *Current Sleep Medicine Reports*, *1*, 64–73. https://doi.org/10.1007/s40675-014-0002-8

LeBourgeois, M. K., Giannotti, F., Cortesi, F., Wolfson, A. R., & Harsh, J. (2005). The relationship between reported sleep quality and sleep hygiene in Italian and American adolescents. *Pediatrics*, *115(Suppl 1)*, 257–265.

Liu, A. H., Zeiger, R., Sorkness, C., Mahr, T., Ostrom, N., Burgess, S. … & Manjunath, R. (2007). Development and cross-sectional validation of the childhood asthma control test. *Journal of Allergy and Clinical Immunology*, *119*, 817–825.

Luyster, F. S., Teodorescu, M., Bleecker, E., Busse, W., Calhoun, W., Castro, M. … & Wenzel, S. E. (2012). Sleep quality and asthma control and quality of life in non-severe and severe asthma. *Sleep and Breathing*, *16*, 1129–1137. https://doi.org/10.1007/s11325-011-0616-8

Marco, C. A., Wolfson, A. R., Sparling, M., & Azuaje, A. (2012). Family socioeconomic status and sleep patterns of young adolescents. *Behavioral Sleep Medicine*, *10*, 70–80.

McQuaid, E. L., Everhart, R. S., Seifer, R., Kopel, S. J., Mitchell, D. K., Klein, R. B. … & Canino, G. (2012). Medication adherence among Latino and non-Latino white children with asthma. *Pediatrics*, *129*, e1404–e1410.

McQuaid, E. L., Walders, N., Kopel, S. J., Fritz, G. K., & Klinnert, M. D. (2005). Pediatric asthma management in the family context: The family asthma management system scale. *Journal of Pediatric Psychology*, *30*, 492–502.

Meltzer, L. J., Plaufcan, M. R., Thomas, J. H., & Mindell, J. A. (2014). Sleep problems and sleep disorders in pediatric primary care: Treatment recommendations, persistence, and health care utilization. *Journal of Clinical Sleep Medicine*, *10*, 421.

Mindell, J. A., Meltzer, L. J., Carskadon, M. A., & Chervin, R. D. (2009). Developmental aspects of sleep hygiene: Findings from the 2004 National Sleep Foundation Sleep in America Poll. *Sleep Medicine*, *10*, 771–779.

Mindell, J. A., & Owens, J. (2015). *A Clinical Guide to Pediatric Sleep: Diagnosis and Management of Sleep Problems*. Philadelphia, PA: Lippincott. Williams & Wilkins.

Nathan, R. A., Sorkness, C. A., Kosinski, M., Schatz, M., Li, J. T., Marcus, P. … & Pendergraft, T. B. (2004). Development of the asthma control test: A survey for assessing asthma control. *Journal of Allergy and Clinical Immunology*, *113*, 59–65.

National Heart Lung and Blood Institute. (2007). *Guidelines for the diagnosis and management of asthma*. National Institutes of Health.

Owens, J., Spirito, A., McGuinn, M., & Nobile, C. (2000). Sleep habits and sleep disturbance in elementary school-aged children. *Journal of Developmental and Behavioral Pediatrics*, *21*, 27–36.

Spilsbury, J. C., Storfer-Isser, A., Drotar, D., Rosen, C. L., Kirchner, L. H., Benham, H., & Redline, S. (2004). Sleep behavior in an urban US sample of school-aged children. *Archives of Pediatrics & Adolescent Medicine*, *158*, 988–994.

Turyk, M. E., Hernandez, E., Wright, R. J., Freels, S., Slezak, J., Contraras, A. … & Persky, V. W. (2008). Stressful life events and asthma in adolescents. *Pediatric Allergy and Immunology*, *19*, 255–263. https://doi.org/10.1111/j.1399-3038.2007.00603.x

U.S. Department of Health and Human Services. (2014). *2014 Poverty guidelines*. Retrieved from http://aspe.hhs.gov/poverty/14poverty.cfm

Wilson, K. E., Miller, A. L., Lumeng, J. C., & Chervin, R. D. (2014). Sleep environments and sleep durations in a sample of low-income preschool children. *Journal of Clinical Sleep Medicine*, *10*, 299.

Witcher, L. A., Gozal, D., Molfese, D. M., Salathe, S. M., Spruyt, K., & Crabtree, V. M. (2012). Sleep hygiene and problem behaviors in snoring and non-snoring school-age children. *Sleep Medicine*, *13*, 802–809.

Zafar, A. B., Ness, J., Dowdy, S., Avis, K., & Bashir, K. (2012). Examining sleep, fatigue, and daytime sleepiness in pediatric multiple sclerosis patients. *Multiple Sclerosis Journal*, *18*, 481–488. https://doi.org/10.1177/1352458511424307

Zuckerman, B. (2014). Growing up poor: A pediatric response. *Academic Pediatrics*, *14*, 431–435. https://doi.org/10.1016/j.acap.2014.05.007